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Geology of an Area around Kohn Lake

Part of NTS Area 64M-SE

by J. F. Lewry

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Foreword

This report is published by the Saskatchewan Geological Survey as one of a series of reports resulting from a four-year program of geoscience surveys under the terms of the Canada-Saskatchewan Agreement on Mineral Exploration and Development in Northern Saskatchewan. This program is supported by funds provided by the Federal Departments of Energy, Mines and Resources (25 percent) and Regional Economic Expansion (25 percent) as well as by the Province of Saskatchewan (50 percent).

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February, 1982

Abstract

The area around Kohn Lake forms part of the Mudjatik Lithostructural Domain. Metasediments of the Wollaston Group occur as northeast-trending belts in the south and east of the area. Metasediments of the Many Islands belt, much lower in metamorphic grade than those of the Wollaston Group, form the nose of a synform in the extreme north. Most of the area is underlain by migmatites, felsic and granitoid gneisses, and later massive leucogranite and biotite granite, termed collectively the "infrastructural complex". This complex underlies the Many Islands belt and is interfolded with the Wollaston Group. Two major fold/foliation-forming episodes, accompanied and outlasted by uppermost amphibolite to granulite facies metamorphism, are recognized in the Wollaston Group and the infrastructural complex. The Many Islands belt occupies the core of a regional-scale synform and is interpreted as high-level superstructure. Restricted northeast-trending cataclasite/mylonite zones and later north-south faulting are also recognized.

Preferred mineral exploration targets are considered to be the Wollaston Group and the junction zone between the Many Islands belt and infrastructural complex.

Keywords: Saskatchewan, 64M-SE, Kohn Lake, Precambrian, Churchill Province, Mudjatik Domain, Wollaston Domain, Many Islands belt

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Map

222A. Geology of an Area around Kohn Lake ..... (back pocket)

Introduction

The area described in this report covers approximately 2900 km^2 and is centred about 190 km east of Stony Rapids, adjacent to the Saskatchewan-Manitoba border (Figure 1). It includes all but the southeastern part of the Phelps Lake Southeast map sheet (NTS area 64M-SE). There is no permanent settlement or habitation. Apart from water-based air transport, access is easily available only from the south via Wollaston Lake and the Cochrane River system.

Previous Work

Initial reconnaissance geological mapping of the Phelps Lake sheet (NTS 64M) was carried out by Tremblay (1960) at a scale of 1:250 000. Saskatchewan Mineral Resources reports and geological maps, at a scale of 1:63 360, are published for the Dutton Lake (east half) area to the northeast (Munday, 1973) and for the Hara Lake (Kays, 1972) and Charcoal Lake (Scott, 1972) areas to the southeast of the present report area. Contiguous parts of northwestern Manitoba were mapped by Weber et al. (1975).

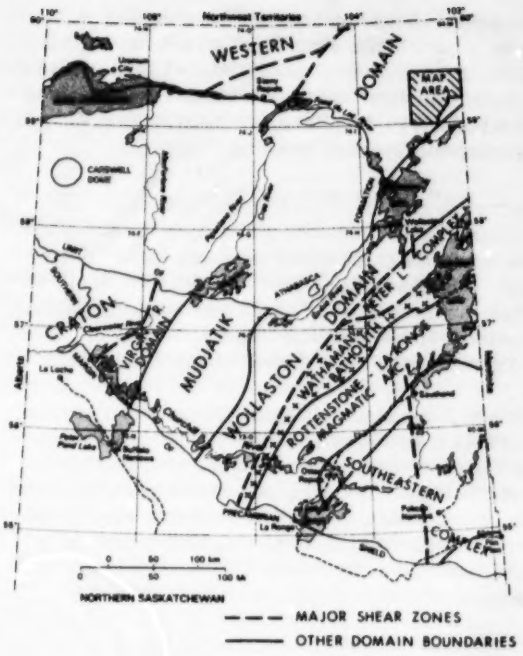

Figure 1. Major features of the Precambrian Shield in Saskatchewan and location of map area

Fieldwork and Acknowledgements

Fieldwork was carried out during the summer of 1979. Most work was by pace-and-compass traversing, only a few of the larger lakes having sufficient lakeshore outcrop to warrant detailed shoreline mapping. Many isolated outcrops were visited by helicopter during two days at the end of the field season. All fieldwork was preceded by detailed aerial photograph inspection and outcrop spotting by float plane. Data were plotted on airphotos and base maps at a scale of approximately 1:63 630. Pre-season analysis of available geophysical and geological data, and company assessment work was also undertaken.

All field maps and most airphotos were destroyed by fire in the office tent two days before the close of the field season. Most field notes were preserved or were partly reconstructed from partially burnt material and from memory. The present map and report were prepared from these notes, supplemented by geophysical data and assessment work. Despite some loss of data, the geological map is thought to be little inferior in quality and detail to that which would have resulted had the accident not occurred.

The field crew comprised C.J. Rees, K. Roberts and P. Maw, senior assistants; D. Eley, B. Robb, M. McDonell and L. Donelly, junior assistants; and D. Ireland, cook. Their competence and hard work, often under trying circumstances, is gratefully acknowledged, as is the aid given by personnel of La Ronge Aviation Limited.

Physiography and Surficial Geology

Bedrock exposure generally amounts to less than 1 percent throughout most of the area. Relief is generally low, the terrain being flat or gently rolling with extensive areas of irregular hummocky to drumlinoid boulder ridges and intervening swampy depressions. Lakes are generally very shallow and strewn with boulders.

The bulk of the area is mantled by very coarse to sandy unsorted boulder drift with lesser areas of esker-related fluvioglacial outwash sand. Muskeg is extensive, principally in the northwest and south. The present writer concurs with Munday (1973) in interpreting the drift and resultant terrain as characteristic of dead-ice moraine.

Drift fragments are generally of rock types seen in bedrock exposure. Some widely scattered erratics of undeformed grey-green sandstone and polymictic conglomerate are thought to derive from well outside the area, probably from the Northwest Territories.

General Bedrock Geology

All consolidated rocks are of Precambrian age. The area (Figure 1) lies in the Mudjatik Lithostructural Domain (Lewry and Sibbald, 1977, 1980; Lewry et al., 1978). Transition into the Wollaston Domain occurs immediately to the southeast. Three major geological components are distinguished (Figure 2).

In the extreme north-central part, semipelitic to pelitic argillites, phyllites and schists (Unit 1) of low metamorphic grade are interlayered with calc-silicates and dolomitic marbles (Unit 2) in the fault-disrupted nose of a tight northeasterly-plunging synform. These units form the southwestern extremity of the *Many Islands belt* (Munday, 1973).

Very high metamorphic grade feldspathic quartzite (Unit 4), graphitic semipelitic to pelitic biotite felsic gneisses (Unit 5), pelitic gneisses (Unit 6) and minor mafic and calc-silicate gneisses and granulites (Unit 3), all assigned to the *Wollaston Group* (Ray, 1979), form several northeast-trending belts in the south and east. Such rocks are more abundant in the adjacent Hara Lake map area (Kays, 1972).

The remainder of the area comprises an *infrastructural complex*, of varied migmatitic and granitoid gneisses and more homogeneous granitic rocks, which structurally underlies the Many Islands belt and is thought to be tightly interfolded with metasediments of the Wollaston Group. Adjacent to the Wollaston Group metasedimentary belts, parts of this complex consist of banded medium-grained felsic gneisses (Unit 7), the greater part of which may be paragneisses. In the southwest, infrastructural rocks are predominantly waxy-brown to greenish-buff 'charnockitic' gneisses (Unit 8); these appear in part transitional to Unit 7 and to other rocks of the infrastructural complex, and are thought to include both paragneisses and orthogneisses.

Most of the infrastructural complex comprises varied agmatitic, banded, schollen and schlieric migmatites intermixed with more nebulitic to homophanous granitic to tonalitic rocks (Unit 9)[1]. These pass diffusely and extensively into massive or weakly foliated alaskite, leucogranite and quartz monzonite (Subunit 10a), interpreted as anatectic derivatives of

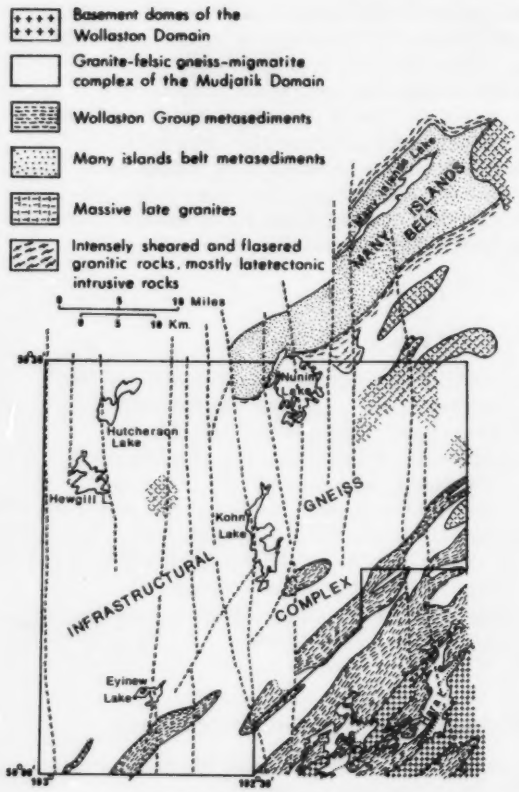

Figure 2. General geology of the Kohn Lake area and environs

the migmatitic gneisses . More homogeneous, massive magmatic biotite granite and quartz monzonite (Subunits 10b, 10c), which occur most prominently in the northeast, are thought to have been generated by progressive melting and mobilization. Similar but highly deformed granite (Subunit 10d) is intruded along much of the junction between the infrastructural complex and the Many Islands belt to the north of the present map area.

Generally, all rocks in the area have undergone extensive postkinematic recrystallization or magmatic consolidation. Locally, however, a later cataclastic shear fabric has produced protomylonites and mylonites of uncertain antecedents (Unit 11).

[1]migmatite terminology after Mehnert (1968)

Description of the Rock Units

Many Islands Group

The Many Islands group is very poorly exposed in the present area and no stratigraphic relations have been established. Two main rock units are distinguished; these are generally interlayered, in variable proportions, in the few outcrops present.

'Argillite', Siliceous Siltstone, Phyllite and Mica Schist (Unit 1)

Rocks of this unit are generally very fine grained semipelitic metasediments with subordinate pelitic and psammitic interlayers. They are typically dark grey or locally buff-brown from weathering, and display regular fine lamination and a larger scale layering which varies from a few centimetres to several tens of centimetres. Thin psammitic layers are generally lighter grey to buff, but most layering consists of alternating fine-grained silty semipelitic and more micaceous a[illegible]ic laminae. A phyllitic to schistose mica fabric is evident in coarser grained representatives; some aphanitic variants show slaty parting parallel to compositional layering.

Most rocks in the unit are equigranular, with a granoblastic-equant to nematoblastic quartz-feldspar fabric, and green to brown biotite, chlorite and minor muscovite-sericite defining a more or less well-developed schistosity. Fine-grained opaque minerals are common in some specimens and small sparse garnets occur locally, particularly close to the margins of the Many Islands belt. Fine layering is defined by variation in the proportion of felsic and micaceous constituents; some laminae are notably quartz-rich.

Thin layers (3 to 10 cm thick) or discontinuous boudins of greenish to grey calc-silicate commonly occur in subordinate amounts. Elsewhere the argillite-siltstone is interlayered on all scales with subordinate calc-silicate and marble (Subunit 1b). On the map, outcrop areas with greater than 50 percent calc-silicate and marble are assigned to Unit 2.

One outcrop near the southwestern extremity of the Many Islands belt is formed entirely of sparsely garnetiferous, massive, buff-white leucotonalite and white trondhjemite pegmatite (Subunit 1a). Another, on the west shore of Nunim Lake, comprises similar garnetiferous leucotonalite containing small zenoliths of dark grey, fine-grained banded granulite. Both these occurrences have been tentatively correlated with Unit 1. An outcrop in the infrastructural complex near the southwestern extremity of the Many Islands belt contains chaotic schlieren of medium-grained psammitic biotite felsic gneiss in granitoid gneisses and later pink granite neosome; these paragneiss remnants may derive from the Many Islands belt. In general, other lithological evidence pertaining to age and structural relations of the Many Islands metasediments and underlying infrastructure is lacking in the area.

Calc-Silicate Rocks and Dolomitic Marble (Unit 2)

Calc-silicate rocks and dolomitic marble are commonly associated with each other in variable proportions, forming well-layered sequences, in places with intercalated argillite-siltstone. Weathered surfaces are characteristically fretted, with greater preferential erosion of the marble layers leaving ridges of calc-silicate and siltstone.

The calc-silicate members are generally pale green to greenish grey, fine to medium grained and variably massive to well banded. Local coarse-grained bands occur. Mineral content is highly variable: the main constituents are generally calcic plagioclase and diopside and/or amphibole (tremolite or hornblende), with less consistent occurrence of carbonate, scapolite, phlogopitic mica, quartz, epidote, and biotite or chlorite. Minor amounts of magnetite and pyrite are locally present. Textures are generally granoblastic to decussate, though diopside locally forms large poikiloblastic crystals.

The marble members are white or grey on fresh surface, commonly weathering to a buff or light brown colour. They consist predominantly of a granular or saccharoidal mosaic of dolomitic carbonate crystals from 1 to 10 mm in size, with subordinate to minor phlogopite, diopside and tremolite. Diopside locally forms large xenoblastic porphyroblasts. Variants grade from almost pure dolomite to carbonate-poor calc-silicate. Subordinate layers of argillite-siltstone also occur.

Wollaston Group

Metasediments of the Wollaston Group occur in a major belt extending southwestwards from Wilken Lake through Holtby Lake to close southwest of Gleason Lake; in an ill-defined elliptical area southwest of Kohn Lake; in a northeastwards-closing belt south of Eyinew Lake; and in a small strip near the southwest corner of the area (Figure 2). Smaller, generally unmappable remnants of similar rocks occur sporadically throughout the southeastern part of the infrastructural complex. No stratigraphic relations were established, but four main lithological units were differentiated.

Mafic and Calc-Silicate Gneisses and Granulites (Unit 3)

Mafic granulites[1] and calc-silicate rocks, a minor component of the Wollaston Group, generally occur as thin intercalations or as isolated outcrops in other units and are rarely extensive enough to be distinguished on the map. They range from greenish grey diopside-plagioclase-quartz rocks, locally displaying good layering, to mafic or ultramafic amphibolitic or pyribolitic granulites, locally containing hypersthene and diopsidic clinopyroxene. Hornblende is deep green to brown and plagioclase is normally calcic andesine to labradorite. Most types contain biotite in scattered crystals or thin schistose partings. The succession in the fold nose west of Gleason Lake includes mafic-poor plagioclasites and pyriclasites interbanded with more mafic amphibolite or pyribolite gneiss.

Quartzite and Feldspathic Quartzite (Unit 4)

Quartzitic metasediments, commonly sillimanite bearing, occur mainly in the northwestern part of the belt south of Eyinew Lake. A few scattered outcrops, possibly of the same stratigraphic unit, occur on the southeast side of the belt. Quartzitic layers are interbedded with rocks of Unit 5 in the central part of this belt (Subunit 4b) and with pelitic gneisses (Unit 6) west of Gleason Lake. They occur less prominently elsewhere in the south and east of the area. Amphibolite-pyribolite mafic gneisses are interbedded with the quartzites south of Eyinew Lake and both north and south of Gleason Lake (designated as Subunit 4c).

The rocks of Unit 4 vary from glassy grey-white orthoquartzite with little or no sillimanite to rusty weathering, yellow-brown to orange, sillimanite-rich quartzite or feldspathic quartzite. Outcrops are massive to flaggy, the rock being nearly structureless or weakly foliated. A better foliation is defined locally by sillimanite-rich partings, micaceous folia or thinly interlayered semipelitic to pelitic biotite gneiss. The quartzites are medium to coarse grained, generally with granoblastic textures; less commonly, they possess a relict foliation defined by quartz and feldspar.

Quartz content varies from 75 to 99 percent and microperthitic orthoclase or microcline comprises 0 to 20 percent of the rock. Sillimanite (trace to 10 percent) forms restricted, discontinuous lensoid folia or subparallel partings and trains of small acicular crystals; preferred linear orientation of the crystals is uncommon to absent. Varieties containing no sillimanite are designated Subunit 4a. Biotite (0 to 5 percent) forms small subidioblastic crystals with strong to weak preferred planar orientation. Magnetite is generally a minor constituent and reddish brown iron-staining commonly occurs along grain boundaries and internal fracturing of quartz. Minor retrograde muscovite is locally present.

Graphitic Semipelitic to Pelitic Biotite Felsic Gneisses (Unit 5)

The dominant rock type in the Wollaston Group is a medium-grained, highly schistose to granulitic, semipelitic to pelitic felsic biotite gneiss, typically graphite bearing. The rock is medium to dark grey on fresh surface but usually weathers rusty brown.

Typical rocks are equigranular-granoblastic medium-grained schists composed mainly of biotite (10 to 25 percent), quartz, plagioclase and microcline. Graphite locally forms from trace amounts up to 3 or 4 percent of the rock. Red subidioblastic garnets, generally small, are a common but neither abundant nor ubiquitous constituent, locally forming up to 10 percent of the rock. Minor sillimanite and groundmass cordierite are locally present. Hypersthene was tentatively identified in a few outcrops but not found in thin section. Grain size averages 0.1 to 0.5 mm. Potassium feldspar content is generally low. Thin beaded to lensoid quartz or quartz-feldspar segregations are commonly developed parallel to foliation and schistosity, but in general little or no granitoid anatectic mobilizate is present.

More psammitic, dark grey to buff variants (Subunit 5b) occur locally, notably in the Holtby Lake area. Minor interlayered grey quartzite, meta-arkose, pelitic cordierite-sillimanite gneiss (Subunit 5d, southeast of Eyinew Lake), calc-silicate rock, and amphibolitic and pyribolitic gneisses (Subunit 5c, east of Gleason Lake) occur locally. In the core of the belt south of Eyinew Lake, graphitic quartzite and meta-arkose (Subunit 5a) form a significant part of the succession as units from a few centimetres up to tens of metres thick.

Pelitic Gneiss (Unit 6)

Highly pelitic gneisses occur in all main outcrops of the Wollaston Group and also as discontinuous strips and schlieren in the infrastructural complex. Rocks of this unit are medium to coarse grained with a coarsely gneissic metamorphic-migmatitic layering comprising discontinuous irregular alternation of dark grey to brown biotite-rich folia and light grey to white quartzofeldspathic *lits*. In many places the white tonalitic leucosome coalesces into a pervasive dominant neosomal component which comprises 30 to 90 percent of the rock enclosing discontinuous

[1]refers to texture rather than metamorphic grade

remnants of pelitic gneiss, largely obscuring the gneissic foliation. Both biotite-rich and tonalitic fractions are locally intruded by discrete coarse-grained to pegmatitic white granitic/tonalitic sheets and irregular masses.

Paleosomal portions of the pelitic gneiss comprise highly variable proportions of almandine garnet (up to 20 percent), cordierite (up to 15 percent), sillimanite (up to 10 percent), biotite (5 to 60 percent), potassium feldspar, plagioclase (generally An_{25-35}) and quartz, with minor opaques, apatite, sphene and secondary muscovite. Some specimens contain small amounts of graphite. Both almandine and cordierite occur either as lensoid porphyroblasts flattened in the early gneissosity or as larger, more equant xenoblastic to subidioblastic porphyroblasts overgrowing the foliation. The early cordierite is commonly highly polygonized. Sillimanite occurs as fibrolitic felts or acicular trains parallel to gneissosity and enclosed in all other minerals, in particular forming cores to early lensoid cordierite. Although biotite locally defines a well-developed schistosity, it generally tends to form randomly oriented patchy aggregates or occurs with poorly defined mimetic orientation subparallel to gneissosity. Potassium feldspar is either microcline or microperthite.

The neosome is generally granoblastic-hypidiomorphic and coarse grained, comprising quartz and variable proportions of plagioclase and microperthitic microcline or orthoclase. In general the rock is granodioritic to tonalitic and biotite-poor, but contains large sillimanite felts and faserkiesel, large blue-violet cordierite crystals and subidioblastic garnet porphyroblasts. Biotite and sillimanite tend to be mutually exclusive in neosome-rich zones; sillimanite occurs with abundant cordierite and garnet, and little biotite.

Minor quartzite, sillimanite meta-arkose, and biotite psammite-semipelite occur locally in the pelites as thin discontinuous layers. Sporadic calc-silicate and amphibolite-pyribolite layers or boudins are also present. Interbanding of pelitic gneiss and quartzite is prominent in some outcrops west of Gleason Lake and west of Payukod Lake (Subunit 6a).

Minor units of pelitic gneiss also occur in outcrops of Unit 5. Units 5 and 6 are distinguished by the general absence, in Unit 5, of sillimanite and cordierite, any coarse gneissic segregation and any signs of extensive anatexis.

Infrastructural Complex

The infrastructural complex includes a great variety of rock types of uncertain or unknown origin, intimately mixed and/or gradational with each other. The main map units described are characterized by variable admixtures of other rock types and transitional or uncertain boundary relations.

Felsic Gneisses (Unit 7)

These rocks are particularly common near the Wollaston Group in the south and east, and also occur widely in the remainder of the complex. They are generally medium-grained, equigranular to somewhat inequigranular, felsic quartzofeldspathic gneisses and granulites distinguished by more or less regular small-scale compositional or gneissic banding. They are locally interlayered with rocks of probable supracrustal derivation.

Typical specimens range from grey-pink to buff or grey-white. Regular foliation on a scale of a few millimetres to several centimetres is defined mainly by sharply bounded to diffuse alternation of quartz-feldspar-rich and more biotitic (or locally hornblende-biotite-rich) folia. This is accentuated locally by colour banding due to variation in proportion of quartz and feldspars or by ill-defined grain-size variation. Biotite usually forms less than 10 percent of the rock and is concentrated in discrete folia; the biotite content locally ranges up to 20 percent. Quartz typically forms 25 to 40 percent of the rock, but some units comprise more than 50 percent quartz. Plagioclase (generally An_{25-30}) and potassium feldspar, usually microcline or microcline-perthite, occur in highly variable amounts; plagioclase is usually predominant or approximately equal in amount to potassium feldspar, though potassium-rich variants also occur. Quartz-feldspar textures are typically granoblastic, with grain size averaging 0.5 mm.; however, a good to weak planar orientation of biotite is commonly present. Minor patches of vermicular quartz-feldspar intergrowth occur. Accessory constituents include garnet, hornblende, diopside and apatite.

The felsic gneisses in many localities display regular interlamination with biotite-rich or amphibolitic layers up to a few centimetres thick and, less commonly, larger scale interlayering up to several metres thick with pelitic-semipelitic biotite gneiss (Subunit 7b) or hornblende gneiss, amphibolite and pyribolite (Subunit 7a). In such cases the felsic gneisses are interpreted as psammitic meta-arkose or metagreywacke paragneisses. Generally, however, such layering is absent and origin is indeterminate.

In much of Unit 7, medium-grained felsic gneisses grade insensibly into, or are intermixed with coarser more granitoid gneisses possessing little or no regularity of gneissic banding. Development of coarse granitic or pegmatitic *lits* and beaded

pinch-and-swell segregations is common, as is local passage to massive leucogranite.

Although considerable parts of Unit 7 may constitute refoliated and transposed early neosomal or orthogneissic material, the bulk of the unit is thought to derive from psammitic metasediments.

Waxy 'Charnockitic' Gneisses (Unit 8)

The southwestern part of the infrastructural complex is distinguished by the general occurence of granulite or near-granulite facies gneisses, many of which contain orthopyroxene and/or have a waxy 'charnockitic' appearance. Much of the unit appears to be equivalent to rocks in Units 7 and 9. Three main components[1] have been distinguished:

1) **Orthogneisses:** These rocks are medium- to coarse-grained and range from creamy buff or buff-brown to distinctly waxy brown or greenish. They are generally homogeneous and lack banding, but range from well-foliated gneisses to semi-massive 'granulites'. Colourless clinopyroxene and hypersthene occur in amounts ranging from trace to 10 percent or more of the rock, generally as xenoblastic to granular crystals but locally as large poikiloblasts. Hypersthene is commonly partially altered to green or brown biotite and/or amphibole. Brown biotite (2 to 10 percent) forms scattered unoriented flakes. Plagioclase (An_{25-30}), in places antiperthitic, is generally the dominant feldspar, with microperthitic orthoclase or microcline occurring in variable minor to subordinate amounts. Quartz forms 20 to 40 percent of most specimens. The rocks generally have a granoblastic texture.
2) **Banded paragneisses:** These are typically interbanded felsic and biotitic semipelitic to pelitic gneisses. Layering is on a scale of 50 cm to several metres. The felsic gneiss is buff to waxy brown, the biotite gneiss granular and rusty brown. They are considered correlatives of well-layered 'semipelitic' and 'psammitic' assemblages occurring locally in Unit 7. The 'semipelitic' layers, however, are deeper waxy brown and hypersthene occurs locally. The 'psammitic' layers are buff-brown rather than grey-pink, and again hypersthene is present locally.
3) **Pyriboilites and pyriclasites:** These mafic granulites, which occur sporadically as banded sequences or remnants in the more homogeneous orthogneisses, are essentially the same as rocks of Unit 3 or the mafic granulite intercalations in Unit 7.

One occurrence of a distinctive hypersthene-garnet-quartz rock comprises about 30 to 40 percent hypersthene and the same amount of garnet, the remainder being almost entirely quartz with minor iron oxides.

Isolated outcrops of pink massive leucogranite and grey-pink granitoid or felsic gneisses occur in the general area underlain by Unit 8. The relation of these rocks to the waxy gneisses is unknown.

Granitoid Gneiss and Migmatite (Unit 9)

The infrastructural complex is mostly formed by variously banded, agmatitic, schollen and schlieric migmatitic gneisses intermixed with more nebulitic to homophanous[1] granitoid gneisses and variable proportions of leucogranitic rocks of Unit 10. In general, these correspond to the "felsic gneisses" of Munday (1973) and the "gneiss migmatite - migmatite" of Kays (1972). Included in Unit 9 are rocks incorporating appreciable amounts of 'older' granitoid gneiss and migmatitic paleosome as well as leucogranite mobilizate. Subunit 9a rocks generally comprise predominant granitoid gneiss and schollen-schlieric migmatites, whereas Subunit 9b includes mainly subordinate schlieric to nebulitic gneisses with pervasive, predominant leucogranite mobilizate. Areas of Subunit 9b pass gradually and irregularly into pink leucogranite and granite of Subunit 10a, which includes little or no paleosome other than variable mafic granulite remnants.

A major portion of Unit 9 comprises schlieric, nebulitic to homophanous granitoid gneisses of unknown and probably diverse origin. They are most commonly medium- to coarse-grained, grey-pink to grey-buff granodioritic to monzogranitic gneisses; however, all variants from red-pink syenogranitic to grey or white tonalitic-quartz dioritic gneisses occur. Tonalitic types are locally predominant in eastern parts of the area and occur sporadically elsewhere. These compositional variants are not distinguished on the map due to highly complex relations.

The infrastructural gneisses typically possess a streaky to indefinitely and diffusely banded gneissic foliation defined by discontinuous wispy to streaky biotite and/or hornblende concentrations and vague lensoid to semicontinuous variation in grain size or proportions of quartz, feldspar and mafic minerals; *lit par lit* intercalation of coarser foliated or massive leucosomal granite or granodiorite commonly occurs. Although the gneissosity is locally expressed by preferred orientation of quartz and feldspar, later granoblastic equigranular to inequigranular

[1]not to be confused with the subunits in the map legend

[1]migmatite terminology after Mehnert (1968)

recrystallization is more general, and the foliation is a relict feature defined only by gross mesostructural fabric features. Diffuse passage into essentially massive rocks of the same composition is common. In these massive rocks, relict foliation is preserved only by faint variation in mineral proportions and by inherited paleosomal schlieren, generally of amphibolite or pyribolite. Such 'recrystallates' apparently display *in situ*, largely *in solidus* reconstitution, though distinction from anatectic mobilizate is not everywhere possible.

Biotite forms up to 10 percent of the granitoid gneisses, occurring as well-oriented to random subidioblastic crystals. Hornblende is not common, save in schlieric to nebulitic gneissose concentrations. Plagioclase (generally An_{25-30}) is locally antiperthitic. Potassium feldspar is untwinned orthoclase, microcline or microperthitic variants of either. Quartz (from 10 to 15 percent to more than 50 percent) occurs as equigranular granoblastic aggregates to highly inequigranular crystals with lobate interlocking grain boundaries. Patchy quartz-feldspar vermicular or graphic intergrowth commonly forms a small part of the quartz-feldspar mosaic, and small blebs of quartz are common in the feldspars.

Some outcrops display discontinuous interlayering of medium-grained, locally well-banded 'psammitic' felsic biotite gneiss, similar to rocks of Unit 7, and coarser gneissic granitic or granodioritic material. Locally, quartzitic to meta-arkosic or pelitic-semipelitic metasediments occur as older paleosomal rafts and schlieren in the granitoid gneisses, rarely forming major migmatite zones. Most commonly, however, the older paleosome component comprises amphibolite, pyribolite or hornblende gneiss. These include almost homogeneous, unbanded, medium-grained mafic to ultramafic amphibolite or pyribolite, well-foliated pyribolite gneiss and well-banded, leucocratic to mafic hornblende-biotite, hornblende-diopside or orthopyroxene-diopside-hornblende gneisses. Felsic segregation or injection along the foliation locally accentuates layering in the paleosome. Elsewhere, intimate small-scale layering of mafic and felsic components suggests that the felsic layers are reconstituted paragneiss layers, indicating derivation from similarly well-banded felsic gneiss of Unit 7. In other localities (e.g. in the region of Kakat and Mitatut Lakes), there are extensive paleosomal zones of well-layered hornblende-rich and hornblende-poor plagioclase-rich gneisses, some showing distinctive regular bands rich in large hornblende porphyroblasts. Such rocks may be metavolcanic or metapyroclastic remnants. More homogeneous mafic/ultramafic rocks may be metalavas or possibly remnants of basic minor intrusives into older basement rocks.

The mafic granulite and gneiss paleosome occurs widely as large and small agmatitic trains and isolated blocks, contorted schollen, schlieric folia, irregular belts and large schlieren on all scales, or as diffuse nebulitic zones both in gneissic granitoid paleosome and in younger unfoliated recrystallate and mobilizate. Local outcrops of the infrastructural complex, particularly in the northwest, are entirely of green-black amphibolite and pyribolite, or include only minor amounts of later granitic to tonalitic net-veining or agmatite neosome. Passage from paleosome to neosome components varies from sharp to diffuse.

The widespread and often abundant occurence of amphibolite and mafic granulite paleosome contrasts with the infrequent occurrence of such rocks in the Wollaston Group. Although some of these mafic rocks may be derived by infrastructural incorporation of the latter, most are interpreted as still older supracrustal or intrusive remnants in the basement complex.

The early migmatitic and granitoid gneisses, comprising old 'supracrustal' remnants, granitoid gneisses and their *in situ* recrystallates, are pervasively incorporated in or invaded by later pink granitic mobilizate of Subunit 10a type, which forms from a few percent to almost 100 percent of outcrop. There is commonly a diffuse pervasive to patchy development of unfoliated red-pink leucogranitic or leucogranodioritic material throughout the older granitoid gneisses; in such diatexites (cf. Mehnert, 1968), no clear distinction between paleosome and derived mobilizate is possible even in hand specimen. Elsewhere, major parts of the outcrop consist of uniform, massive, medium- to coarse-grained pink mobilizate with or without minor, more or less nebulous gneissic remnants. Pink biotite leucogranite, alaskite, pegmatite and aplite also form concordant to discordant sheets and more irregular masses intrusive into more or less reconstituted early gneisses. All of these relations can locally be seen in a single outcrop.

Differentiation between *in solidus* recrystallate and anatectic mobilizate, though locally obvious, is usually difficult and somewhat arbitrary, particularly where the pink mobilizate appears to have remained and resolidified essentially in place. In general, recrystallate is of the same composition as gneissic rocks with which it is transitional. Mobilizate fractions generally differ significantly in composition from the paleosome host or from included fragments.

Late- or Post-Tectonic Granitic Rocks (Unit 10)

Pink to grey-pink, locally reddish, massive or weakly foliated granitic rocks, a minor constituent of the

Wollaston Group, occur as minor to dominant neosome in the infrastructural gneisses and migmatites (Unit 9), and also form more or less homogeneous major bodies in the infrastructure. They are thought to be derived largely by anatexis of earlier rocks and range from more or less *in situ* melt fractions to thoroughly magmatic bodies apparently formed by concentration and coherent intrusion of igneous melt.

Leucogranite (Subunit 10a): The most common rock type is medium- to coarse-grained, equigranular, granoblastic to hypidiomorphic, massive to indefinitely foliated alaskitic leucogranite. Leucogranodioritic variants occur locally. Normally the rock is totally structureless and massive. A weak gneissosity, however, is locally defined by indefinite quartz-feldspar variation, diffuse biotitic folia and weak dimensional orientation of minerals; in most rocks it appears to be a relict feature.

The rock generally comprises quartz, potassium feldspar (typically microperthite or perthitic microcline) and plagioclase (generally An_{15-25}) in approximately equal amounts, but ranges in composition from syenogranite to monzogranite and rarely granodiorite. Small dispersed biotite flakes generally form less than 2 to 3 percent but locally range up to 10 percent in diffuse folia. Magnetite is a minor constituent but locally forms several percent of the rock, sometimes as coarse aggregates or clots. Textures indicate essentially post-tectonic crystallization or recrystallization. Vermicular to graphic intergrowth textures are common, as is the inclusion of small rounded blebs of quartz in plagioclase feldspar crystals. Porphyroid textures occur sporadically and some variants are transitional to porphyritic monzogranite or quartz monzonite of Subunit 10b.

Pink leucogranite occurs in bodies on all scales from thin concordant to discordant stringers, sheets and beaded lenses in felsic and migmatitic gneisses up to major, essentially homogeneous masses many kilometres across. Relation to enclosing host rocks or included paleosome is highly variable, ranging from sharply intrusive to gradational contacts with granodiorite/tonalite recrystallate fractions or older granitoid gneisses. Leucogranite locally forms part or all of the neosome in agmatites and schollen migmatites. Some areas of predominant leucogranite contain sporadic schollen and indefinite to neblitic schlieren of amphibolite or pyribolite.

Porphyritic Monzogranite and Quartz Monzonite (Subunit 10b): Medium- to coarse-grained, commonly porphyritic biotite monzogranite to quartz monzonite (less commonly granodiorite) occurs mainly in the northeast, while less extensive but equally poorly delineated bodies occur around Ingell Lake and as isolated outcrops elsewhere in the infrastructural complex. Nonporphyritic variants are transitional to leucogranites of Subunit 10a, differing mainly in their somewhat higher mafic content, more general homogeneity and more obviously igneous textures. Such rocks are usually totally massive and porphyroid to markedly porphyritic. A weak cataclastic fabric is present locally. Rafts and zenoliths of older granitoid gneisses or amphibolite are not common.

Occurences in the northeast are typically coarse grained, grey to pink and porphyritic, with subhedral phenocrysts of microcline-perthite up to 2 or 3 cm long in a hypidiomorphic groundmass of quartz, plagioclase (generally oligoclase, An_{20-25}) and potassium feldspar. Biotite generally forms from 5 to 8 percent of the rock; hornblende is not common. Magnetite, apatite, zircon and sphene are minor accessories. Composition is generally monzogranitic, though quartz monzonite or granodiorite variants occur. The body around Ingell Lake is generally monzonitic, with blocky feldspars in a groundmass containing up to 10 percent or more of biotite and lesser hornblende.

Fluorite-bearing Granite (Subunit 10c): Fluorite-bearing biotite monzogranite occurs as poorly exposed isolated outcrops in the extreme northeast. The granite is grey to reddish pink and totally massive with a coarse hypidiomorphic texture. Grain size averages 1 to 3 mm. Potassium feldspar phenocrysts slightly larger than average grain size occur infrequently. Biotite (3 to 10 percent) occurs as isolated, randomly oriented crystals or small aggregates. Fluorite forms up to 1 or 2 percent of the rock as anhedral interstitial crystals. Otherwise the rock is compositionally similar to the leucogranites of Subunit 10a or the poorly porphyritic variants of Subunit 10b.

Although no contacts were seen with other late granites, the general composition, texture and spatial association suggest the fluorite granite is comagmatic with other massive granites of Unit 10, and is probably merely a transitional phase of a larger intrusive body as suggested by Munday (1973).

Flasered to Protomylonitic Augen Granite Gneiss (Subunit 10d): Around Cloud Lake in the extreme north of the area, porphyritic igneous rocks similar to those of Subunit 10b are intensely deformed, varying from flasered granite gneisses to locally protomylonitic augen gneisses (Subunit 10d). Spot checks in the Dutton Lake area to the northeast

(Munday, 1973) by the present author indicated that similarly flasered to mylonitic equivalents of the porphyritic quartz monzonite extend more or less continuously along the southeastern margin of the Many Islands belt.

Related outcrops of coarse-grained flasered to gneissic granite occur in the Holtby Lake metasedimentary belt northeast of Gleason Lake. The relation of this body to the metasediments and to occurrences of Subunit 10b in the infrastructural complex is unknown.

Submylonite and Mylonite (Unit 11)

Submylonitic to mylonitic rocks occur locally throughout the area, most commonly in the northeast. In most cases, their derivation from identifiable gneisses is clear and such rocks are indicated by a subscript letter following the map unit number (see legend, Map 222A, back pocket). Mylonitic rocks whose antecedents are uncertain are assigned to Unit 11.

These rocks are generally very fine grained to aphanitic, grey to black or, less commonly, pink with a streaky to laminated mylonitic foliation which generally trends northeast. Mineral content generally comprises quartz and feldspar with indications of fine micas, locally including chlorite and sericite. However submylonitic variants commonly show cataclastic textures and intensive strain in quartz grains, with variable degrees of recrystallization to blastomylonitic textures. Textural and mineralogical features suggest that such mylonite zones formed subsequent to general regional high temperature recrystallization which followed the main D_1 and D_2 deformational events.

Structural Geology

Foliation and Minor Structures

Most rocks of Units 3 to 8 possess a more or less prominent gneissosity. In the metasediments this is commmonly parallel to compositional banding on all scales, much of it interpreted as transposed primary depositional layering. The felsic gneisses (Unit 7) and some of the waxy gneisses (Unit 8) locally also possess a variably well developed regular compositional banding, but its derivation from primary layering is less clear. In the felsic gneisses and pelitic gneisses, and less commonly in other rock types, foliation is accentuated by concordant granitic and pegmatitic *lits*. The early gneissosity in all these rocks, and particularly in the pelitic gneisses, is parallelled by more or less well preserved schistose preferred orientation of biotite, sillimanite and locally other minerals. Schistosity is poorly preserved and commonly absent in the mafic gneisses.

Locally, early foliation is observed axial planar to small intrafolial tight to isoclinal minor folds or fold nose remnants defined by deformation of delicate compositional layering (S_0). The S_1 surfaces contain poorly preserved rodding and mineral streaking, locally coaxial with these folds. These structures, together with more widespread boudinage of amphibolite and other competent layers, are thought to have developed during the first deformation (D_1).

The S_1 foliation is commonly deformed by moderate to tight, locally isoclinal minor folds and small-scale crenulation defining a D_2 deformational phase. Axial planes of D_2 minor folds are generally steeply dipping and trend northeast to east-northeast. Coaxial lineation, rodding and microcrenulation are common; axes of minor folds and lineation generally plunge at low to moderate angles either to the northeast or southwest. Minor D_2 folds locally possess an intense (S_2) axial planar schistosity, although generally this is indefinite or absent.

Migmatites and granitoid gneisses of the infrastructural complex possess a variably well preserved to indefinite S_1 gneissosity; a subparallel mimetic schistosity is preserved best in some early paleosome remnants. Remnants of D_1 and D_2 minor folds are preserved locally, generally in early supracrustal paleosome, less commonly in granitoid gneiss components. Both D_1 and D_2 minor structures are variably affected by granoblastic recrystallization, feldspar blastesis and anatexis, which they in general predate. However, porphyritic granite in the Cloud Lake area and along the margins of the Many Islands belt is intensely foliated, though subject to later granoblastic recrystallization. Some of the concordant neosomal granites also clearly predate D_2 folding.

The D_3 deformation is essentially postcrystalline and its effects are restricted to localized zones, from a few metres to hundreds of metres wide, of low temperature cataclasis, flasering and mylonitization. Northeast-trending D_3 foliation zones and mylonites are most evident in the eastern part of the area, notably between Kakat and Wilken Lakes.

Little structural data has been obtained from the Many Islands belt. Well-developed sedimentary layering is locally deformed by open to moderate minor folds plunging gently to the northeast on steep to vertical axial planes. A weak schistosity oblique to layering and/or parallel to minor fold axial planes is present locally. An earlier kinematic or mimetic fabric parallel to layering also occurs, but this is prominent only close to the margins of the belt. Limited examination of the Dutton Lake area to the northeast confirmed Munday's (1973) observations that much of the Many Islands belt is affected by tight to isoclinal folding, rodding, lineation and a prominent cleavage or schistosity. Foliation intensifies and fabrics become highly schistose to locally mylonitic near the southeastern margin of the belt, with marked transposition of primary layering. This foliation is parallel to intense foliation in the adjacent granitoid rocks.

Large-Scale Structures

A southwest-closing and gently northeasterly plunging major synform is defined by the attitude of bedding in Units 1 and 2 and of foliation in adjacent infrastructural gneisses west of Nunim Lake. Previous mapping (Munday, 1973) indicates that this 'Many Islands synform' is tight with a subvertical axial surface. This major fold, and by implication the coaxial minor folds in the Many Islands belt, evidently postdates development of D_1 foliation in the infrastructural complex.

Sparse data from the south and east of the area suggest that the Wollaston Group occupies the cores of major tight to isoclinal folds which have axial surfaces trending northeast and dipping steeply to the southeast. The relative age of most of these structures is uncertain.

The Wilken-Holtby Lakes belt appears to occupy the core of a complex D_2 synform. Closure is well defined west of Gleason Lake where abundant foliation and minor fold data define a southwesterly closing and moderately northeasterly plunging synform.

Northeastward closure of the metasediments south of Eyinew Lake is implied by aeromagnetic and EM conductor data, and by the apparent repetition of sillimanite quartzite (Unit 4) on either side of the belt. This belt may form the core of a southwesterly

plunging D_2 (or possibly D_1) synform. The small metasedimentary belt in the southwest corner of the area may be a similar structure.

The indicated basinal structure in pelitic rocks southeast of Kohn Lake is based on aeromagnetic interpretation and very little structural data. It is tentatively identified as a D_2 structure on the basis of structural attitudes to the northeast of the basin.

Major fold structures indicated in the infrastructural complex are very tentative. Foliations in the southwestern part of the complex are subvertical and no major fold closures have been identified, although aeromagnetic trends suggest that they might be present. In the northeast, foliation trends and attitudes are more variable and dips are commonly less steep. This area appears to be openly to moderately tightly folded on major D_2 northeast-trending axes.

Apart from north-south features related to late faults, the northwestern third of the area is characterized by a remarkably flat featureless aeromagnetic signature. This contrast with the remainder of the area, supported by sparse field data, suggests the presence of a regional flat-lying (D_1) gneissosity, affected by northeasterly trending, somewhat disharmonic, open D_2 major folds approximately parallel to the Many Islands synform. The regional aeromagnetic maps suggest that this 'flat zone' extends for considerable distances to the north and west of the present map area.

Late Faulting

Faults indicated on the map are located almost entirely on the basis of aeromagnetic signature and generally ill-defined coincident topographic lineaments. Fault segments south of Eyinew Lake are indicated by offset of strong EM conductors related to the graphitic biotite felsic gneiss (Unit 5). No field evidence of fault location was noted, and indicated displacement of geological boundaries is largely speculative.

Aeromagnetic data were also used to locate major fault offsets of the Many Islands belt indicated in Figure 2. The EM conductor data from assessment work, complementing aeromagnetic data, formed the basis of extrapolation of some major faults into the adjacent Hara Lake area (Kays, 1972), and adjustment of some previously mapped geological boundaries.

The north-south fault pattern which dominates the area is thought to be an extension of the 'Tabbernor system', which can be traced southwards to beyond the edge of the Precambrian Shield. The faults evidently postdate all other structural features in the area.

Structural Summary and Correlation

The Wollaston Group and infrastructural complex are deformed by major and minor structures of two main deformational episodes. The D_1 event produced early gneissosity and minor folds, as well as probable major folds, although the latter are not clearly defined. The D_2 event produced northeast-trending major and minor folds in a style which varies from overturned and tight to isoclinal in the southeast to rather open and disharmonic in the north and northeast.

The Many Islands synform refolds D_1 regional foliation; this, together with its general attitude and orientation, indicates that the synform is broadly coeval with D_2 folding elsewhere in the area. However, intense foliation along the margin of the Many Islands belt affects both metasediments and intrusive granite, the latter thought to be derived by anatexis of the infrastructural gneisses. Most anatectic granite fractions elsewhere apparently crystallized after the close of the D_2 folding. Moreover, massive fluorite granite truncates the Many Islands belt to the northeast in Manitoba (Weber et al., 1975). If the proposed structural correlation is correct, then granitic intrusion of two distinct ages must be present, one occurring towards the end of D_2 folding, the other being postkinematic. However, marginal shearing along the Many Islands belt may in fact be later than the main D_2 folding but predate low temperature cataclasis and mylonitic zones elsewhere in the infrastructure.

There appears to be a marked regional change in structural attitudes from southeast to northwest. Kays (1972) demonstrated, in the Hara Lake area, that Wollaston Group-type supracrustals occur generally in D_2 or composite D_1/D_2 synforms between basement granite gneiss domes, a situation common to much of the Wollaston Domain elsewhere. To the northwest, transition to the Mudjatik Domain is marked by steep to subvertical foliations, tighter overturned D_2 folds, loss of clear distinction between basement and cover, increasing anatexis and possible inversion of stratigraphic successions locally. Farther to the northwest, regional D_1 foliation is flat lying and deformed by more open irregular D_2 major folds.

In the southern part of the area, an apparent aeromagnetic discontinuity runs east-west just to the north of Moosejaw and Eyinew Lakes, coinciding approximately with the northerly disappearance of

charnockitic rocks and metasediments, and the appearance of extensive leucogranite neosome in the infrastructure. This feature possibly relates to more marked upflow and overriding of highly mobile material from the north.

Metamorphism

Age Relations and Critical Mineral Parageneses

Age relationships between minor structures, kinematic fabrics and metamorphic minerals, and evidence of widespread anatexis indicate the presence of high to very high grade metamorphic conditions in most rocks of the Wollaston Group and the infrastructural complex during and subsequent to development of D_1 and D_2 structures. Critical metamorphic mineral parageneses and age relations occur principally in pelitic gneisses, mafic gneisses and the waxy charnockitic gneisses.

Pelitic Gneisses

The most complete and diagnostic data on metamorphic conditions and history in the area are available from the pelitic gneisses of Unit 6. In general, mutual grain boundary and other fabric relations indicate the presence of an equilibrium metamorphic paragenesis which developed after the close of major tectonism, though the age of initial growth of the constituent minerals may vary. The typical and critical mineral paragenesis is:

quartz + potassium feldspar (usually perthite) + plagioclase (locally antiperthitic) + biotite + sillimanite + cordierite and/or almandine.

Generally cordierite and almandine co-exist in apparent equilibrium.

Sillimanite forms fibrolitic felts or trains of acicular subidioblastic crystals parallel to S_1 gneissosity; the felts are locally refolded by D_2 microcrenulations. The mineral is enclosed by granoblastic post-tectonic quartz and feldspar, as well as by biotite and early and late cordierite and almandine. Cordierite occurs as 1) flattened lensoid porphyroblasts or polycrystalline lenses enclosing fibrolite felts, parallel to S_1 foliation and locally deformed by D_2 minor folds; 2) more equant, xenoblastic, locally subporphyroblastic crystals forming part of the granoblastic groundmass in the pelitic paleosome; and 3) large violet-blue equant porphyroblasts in massive tonalitic neosome associated with the pelites. Almandine also occurs both as lensoid early porphyroblasts and as later subidioblastic porphyroblasts both in pelitic paleosome and tonalitic neosome. Within the neosome, relict sillimanite sheaves are locally abundant and biotite is generally absent; however, the reverse occurs locally.

Textural evidence thus suggests that the main mineral assemblage was in stable or metastable equilibrium both during or prior to the D_1 deformation and during and subsequent to the D_2 folding.

Extreme anatexis of the pelites is evident. The melt fraction, which forms 30 to over 70 percent of the total rock, is mostly massive and unfoliated, but some foliated *lits* indicate the occurrence of syn-D_1 anatexis.

Data obtained indicate that the reaction:

muscovite + plagioclase + quartz = sillimanite + alkali feldspar (melt) + plagioclase (solid and melt) + H_2O

has proceeded to completion and that temperatures sufficient to allow the reaction:

biotite + sillimanite + plagioclase = almandine + cordierite + quartz-feldspar melt + H_2O

were also exceeded. The composition and amount of melt, and the paucity of biotite indicate the existence of temperatures significantly above the initial melting point, with extensive incongruent melting of biotite.

Mafic Gneisses

Most mafic gneisses possess subequant granoblastic textures overgrowing early gneissic banding. Pronounced schistose preferred dimensional and/or lattice orientation, parallel to early foliation, of pyroxene, hornblende, biotite and rarely quartz-feldspar is less common.

In mafic gneisses of Units 3, 7 and 8, equilibrium mineral parageneses generally comprise:

green-brown hornblende + calcic plagioclase ± quartz ± diopside or colourless clinopyroxene

Hypersthene is a widespread though not ubiquitous constituent in the south, but was rarely enountered in amphibolitic and pyribolitic paleosome remnants in the north and northeast parts of the infrastructural complex.

Waxy Gneisses

Granitic to tonalitic members of Unit 8 locally contain the critical mineral assemblage:

hypersthene + clinopyroxene + biotite ± brown hornblende + perthitic alkali feldspar + antiperthitic plagioclase

Textures are typically granoblastic. Pyroxene is commonly partially retrogressed to green-brown biotite and/or amphibole. Biotite gneiss members of the waxy gneisses also locally contain sparse hypersthene.

The Many Islands Belt

Semipelitic and pelitic metasediments in the belt generally comprise the low grade paragenesis:

biotite ± chlorite + muscovite + albitic plagioclase + quartz

Garnet is not common, except close to the margin of the belt. Cordierite was identified locally by Munday (1973) but not confirmed in the present study. The paragenesis corresponds to uppermost greenschist to lower amphibolite facies. The presence of diopside and scapolite in calc-silicate units indicates attainment of lower amphibolite facies conditions.

Conditions of Metamorphism

The foregoing data indicate the establishment of very high grade regional metamorphic conditions (ie. uppermost amphibolite to granulite facies) at the earliest discernible stage of tectonism, and the persistence of such conditions essentially beyond the close of regional deformation and crustal mobility everywhere except in the Many Islands belt. In the south and southeast, metamorphic mineral parageneses and degree of anatexis of pelitic gneisses suggest that P/T conditions in excess of 720°C at 4 to 6 kbars were attained (Figure 3). In view of the extensive granitic to tonalitic melt elsewhere, it is considered unlikely that temperatures significantly

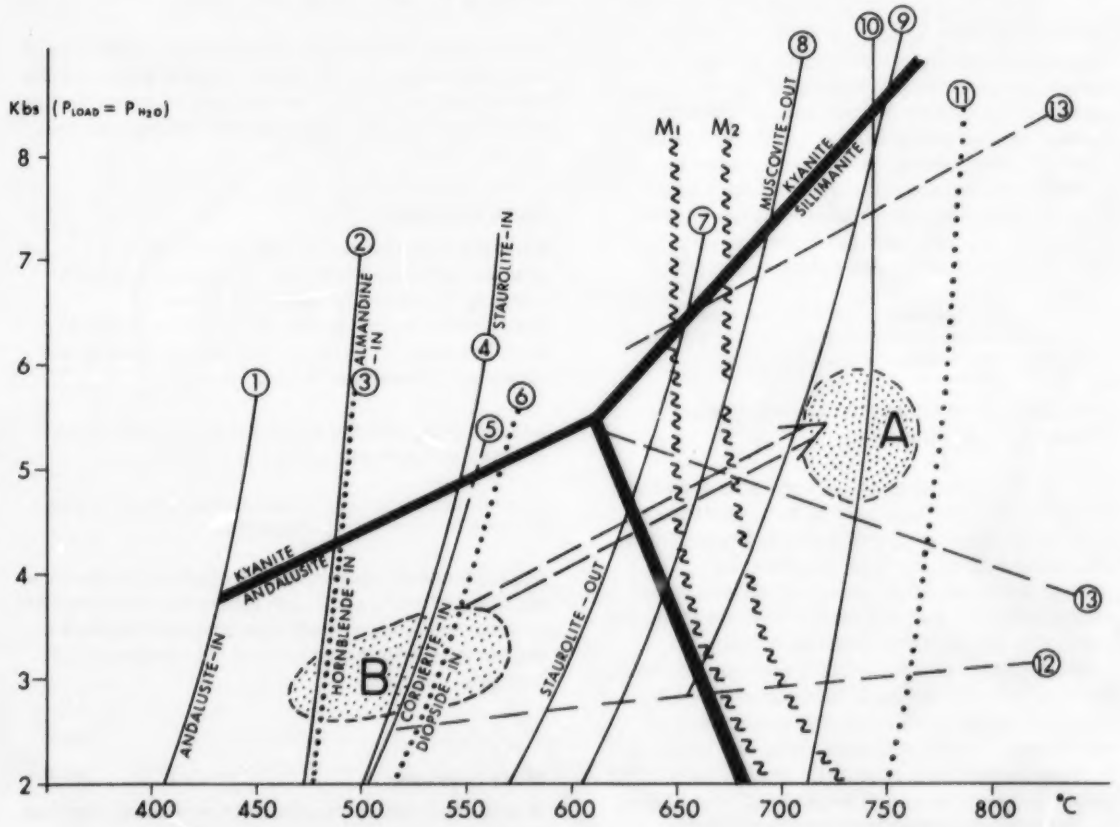

Figure 3. *Pressure-temperature conditions of metamorphism in the Kohn Lake area in relation to significant univariant reaction curves: A, approximate P,T conditions in southwestern part of area; B, approximate P,T conditions in the Many Islands belt*

Univariant reactions (from Winkler (1979) or from references quoted therein):

1, pyrophyllite = andalusite + quartz + H_2O; 2, generalized first appearance of almandine garnet in pelitic rocks; 3, generalized first appearance of hornblende in basic rocks; 4, chlorite + muscovite + garnet = biotite + staurolite + quartz + H_2O; 5, chlorite + andalusite + quartz = cordierite + H_2O; 6, tremolite + calcite + quartz = diopside + CO_2 + H_2O; 7, muscovite + staurolite = biotite + garnet + sillimanite (Al-silicate); 8, muscovite + plagioclase + quartz = sillimanite + alkali feldspar (melt) + plagioclase (solid and melt) + H_2O; 9, biotite + sillimanite + plagioclase = almandine + cordierite + quartz-feldspar melt + H_2O; 10, biotite + garnet = hypersthene + cordierite + K-feldspar (or melt) + H_2O; 11, hornblende + quartz = hypersthene + diopside + plagioclase + H_2O; 12, normal lower pressure limit of almandine garnet in pelitic rocks; 13, approximate limits of co-existing cordierite + almandine + sillimanite + quartz for FeO/(FeO+MgO) ratios of 0.4 to 0.6; M_1, initial melting curve of average pelitic biotite gneiss; M_2, curve representing approximately 50 percent melt of biotite gneiss.

Solid lines represent reactions taking place in normal pelitic rocks; dotted lines represent reactions taking place in basic rocks or calc-silicates.

lower than 700°C prevailed in most of the infrastructure, despite general lack of hypersthene to the north. Development of 'charnockitic' rocks and hypersthene-bearing granulites in the southwest indicates fluid pressures significantly below load pressure. Elsewhere P_{H_2O} was close to or equal to P_{load}, save in local 'dry' rock types, but temperatures were in the same general range.

In most of the Many Islands belt, uppermost greenschist to lower amphibolite facies parageneses were prevalent during both deformation and subsequent granoblastic recrystallization. Metamorphic temperatures in the range 450 to 550°C are generally indicated (Figure 3). Pressure conditions are uncertain, though local development of cordierite (Munday, 1973) in lower amphibolite facies assemblages suggests that pressure did not exceed 3 to 4 kbars.

Discussion and Regional Considerations

Wollaston Domain

Contrasting characteristics of the Wollaston and Mudjatik Domains in the Kohn Lake area are essentially similar to those documented in other areas (e.g. Gilboy, 1977; Ray, 1978; Lewry and Sibbald, 1980). The Wollaston Domain, as seen in the southeastern part of the adjacent Hara Lake area (Kays, 1972), comprises presumed Archean basement gneiss domes of homogeneous granite occupying antiformal closures within a belt of Wollaston Group supracrustal rocks of Aphebian age. Though no detailed stratigraphic relations are established, the overall character of the supracrustal assemblage in the Kohn Lake and Hara Lake areas is typical of lower parts of the Wollaston Group elsewhere (Ray, 1977, 1978; Lewry and Sibbald, 1979, 1980), comprising graphitic and nongraphitic pelites and semipelites with variable subordinate calc-silicate rocks and quartzite or meta-arkose.

Transition Between the Wollaston and Mudjatik Domains

Transition to the Mudjatik Domain is marked regionally by a more or less abrupt change to varied inhomogeneous granitic and migmatitic gneisses interfolded with Wollaston Group metasediments. In the present area the precise nature of the transition is obscure. However, certain features are of possible significance. For example, the felsic gneisses of Unit 7 are interpreted mainly as a highly reconstituted and partially melted succession of psammitic paragneisses with subordinate calc-silicate and pelitic-semipelitic intercalations. Less modified parts of the unit, both in the present area and in the adjacent Hara Lake area, resemble the "Upper Meta-Arkose" succession of the Wollaston Group elsewhere in the Wollaston and Mudjatik Domains. Present data also indicate that these psammitic rocks structurally *underlie* Wollaston Group metasediments of Units 3 to 6 in the Gleason Lake area and possibly elsewhere, though they overlie pelites and calc-silicates adjacent to basement inliers in the Hara Lake area. Outcrop relations in the Hara Lake area suggest considerable structural discordance associated with incoming of felsic gneisses and migmatites to the northwest. However, this may be illusory and a function of progressive reconstitution rather than tectonic discordance.

If postulated stratigraphic correlations are correct and structural relations are as indicated, then an abrupt and major stratigraphic inversion is present. This postulated inversion coincides broadly with apparent structural discordance attending the transition from the Wollaston Domain to the Mudjatik Domain. Such features might be accomodated by a model of early (D_1) nappe lobe development in which the domain junction coincides with overriding of the autochthonous Wollaston Domain by recumbent structures derived from the northwest. Both autochthon and the nappes were then refolded by D_2 major folds. This model is similar to that proposed by Ray (1978) for the Collins Bay-Wollaston Lake area and is consistent with the more general thermotectonic model developed by Lewry and Sibbald (1980).

A number of other interpretations may be made:

1) The correlation of Units 3 to 6 with lower parts of the Wollaston Group is incorrect. This is unlikely in view of relations seen in the Hara Lake area and in the Kasmere Lake area (Weber et al., 1975).
2) The correlation of Unit 7 with the Upper Arkosic Group is incorrect and no stratigraphic inversion is in fact present. In this event the felsic gneisses must represent Archean basement or a basal Aphebian arkosic unit not observed elsewhere in the Wollaston and Mudjatik Domains, save on the extreme eastern margin of the Wollaston Domain (Coombe, 1977).
3) Structural relations are even more complex than those postulated here.

The restriction of waxy 'charnockitic' gneisses to the southwestern part of the area is considered to be largely a function of abnormally low fluid pressures in this region, rather than an indication of metamorphic temperatures or confining pressures significantly higher than elsewhere. Metamorphic mineral parageneses in the Wollaston Group and in much of the infrastructural complex are consistent with P/T conditions appropriate to the transition between the uppermost amphibolite and the granulite facies (as elsewhere in the Mudjatik Domain). Granulite facies parageneses occur sporadically in 'drier' mafic granulites scattered throughout the area. The passage to increasing anatexis and abundant nebulitic migmatites and granite to the northwest is considered primarily a function of increasing fluid pressures and possibly of upward migration/concentration of melt fractions, rather than being a temperature-dependent phenomenon.

Nonetheless, the passage to low-grade rocks of the Many Islands belt, increasing concentration of anatectic melt and increasing incidence of magmatic plutons to the northeast all suggest passage to a relatively high level in the infrastructure and must presumably be accompanied by a more or less rapid decline in metamorphic grade in the infrastructure adjacent to and below the Many Islands belt. In other

words, the increase in granitic rocks accompanies decreasing temperature at these higher structural levels. These features are in contrast to most of the Mudjatik Domain to the southwest and, together with appearance of the 'superstructural' Many Islands belt, suggest a general regional plunge of the Mudjatik Domain to the northeast.

Transition Between the Mudjatik Domain and the Many Islands Belt

Available data indicate either a sharp metamorphic break or a pronounced metamorphic transition from the infrastructural complex to the Many Islands belt. Evidence bearing on this problem is scant, indirect and indecisive, since most infrastructural rocks adjacent to the Many Islands belt are granitic. However, it is noted that:

1) There is a general increase in metamorphic grade from the interior to the margins of the Many Islands belt, indicated by increasing grain size and development of platy minerals in the pelitic-semipelitic members. Munday (1973) recorded sillimanite + muscovite in a gneiss less than 2 km southeast of the boundary of the belt, suggestive of medium-grade (mid-amphibolite facies) metamorphic conditions.
2) Rocks of the interior and margins of the Many Islands belt and of the adjacent infrastructure share a general post-kinematic granoblastic recrystallization fabric. Even intensely flasered to mylonitic rocks adjacent to the junction between the two are granoblastically recrystallized. Restricted zones of cataclasis in the infrastructure appear later than this marginal shearing and general recrystallization.
3) There is no evidence of widespread retrogression of high-grade mineral parageneses in the infrastructure or Wollaston Group, such as might be expected if the low-grade metamorphism of the Many Islands belt was a distinctly later event than high-grade metamorphism in the infrastructure.
4) Marginal relations indicate that granitic rocks generated by anatexis of the infrastructure *intrude* metasediments of the Many Islands belt and were sheared and recrystallized together with the metasediments.

Accordingly it is concluded that metamorphism of the Many Islands belt and infrastructural complex was approximately coeval, and that differences are related to rapid transition from one thermotectonic crustal level to another. There is no metamorphic evidence that the Many Islands metasediments were deposited subsequent to observed high-grade metamorphism and anatexis in the infrastructure.

Although the infrastructural complex may quite possibly consist largely of remobilized Archean basement, there is no persuasive evidence of unconformity at the present margin of the Many Islands belt. Those margins are intensely sheared, with evidence of prior intrusive contacts. Most of the adjacent granitic rocks on the southeastern margin are interpreted as Hudsonian intrusive bodies. They resemble late tectonic 'junction granites' described elsewhere in northern Saskatchewan (Lewry and Sibbald, 1979, 1980; Lewry, 1977) and include xenoliths of argillite (Unit 1). It seems highly improbable that undeformed polymictic conglomerate and sandstone erratics seen in the area represent a basal conglomerate to the Many Islands Group as suggested by Munday (1973), and thus the possible economic significance of these rocks suggested by Munday is unfounded.

Status of the Many Islands Group.

It is speculated that metasediments of the Many Islands belt may not in fact be autochthonous but may have been emplaced in their present position as part of a high-level allochthonous tectonic slice at an early stage in Hudsonian thermotectonism. Such an emplacement mechanism may to some extent account for the abrupt contact with the infrastructure and accomodate problems of correlation with the Wollaston Group.

Despite their proximity, no obvious correlation is evident between the Wollaston Group and the Many Islands Group. Munday (1973) has suggested that the Many Islands Group may correlate with the Hidden Bay assemblage (Wallis, 1971; Ray, 1978) regarded as the uppermost part of the succession in the Wollaston Lake area. Weber et al. (1975) have also suggested correlation with upper parts of the Wollaston Group. If such is the case, the absence of underlying lower parts of the Wollaston Group must indicate either a major erosional interval or profound tectonic discordance. The latter explanation is preferred here. The alternative possibility, that the Many Islands Group postdates deposition and deformation/metamorphism of the Wollaston Group, is rejected for reasons already discussed in this report.

Economic Geology

The high-grade granitoid infrastructure of the Mudjatik Domain is not regarded as a favourable exploration target. Despite intense exploration activity, no economic mineralization has yet been found in the Mudjatik or Wollaston Domains except at the contact between crystalline basement and the Athabasca Group. Subeconomic uranium concentrations have, however, been noted in pegmatoid anatectic fractions elsewhere in the domain (Sibbald, 1975; Lewry and Sibbald, 1979). Base metal and uranium mineralization of Aphebian-Hudsonian age also occurs, most commonly in lower parts of the Wollaston Group, particularly adjacent to basement/cover contacts (Weber et al., 1975; Ray, 1976, 1977; Potter, 1977; Thomas, 1978, 1979; Lewry and Sibbald, 1979). Such locations, particularly in the Hara Lake area, are thus possible exploration targets.

It has been suggested (Lewry and Sibbald, 1979) that uranium concentration in pegmatitic and granitic melt fractions of Hudsonian age is preferentially related to zones of intense Hudsonian shearing, particularly where these mark junctions between areas of differing crustal mobility and thermotectonism during the Hudsonian (e.g. the Black Lake Shear Zone and Grease River Belt). Thus the junction zone between the Many Islands suprastructure and adjacent infrastructure may warrant further investigation.

The present area has been extensively prospected and investigated by mining companies, particularly in the late sixties and early seventies, without apparent success. Further exploration was being carried out in the Hara Lake area during the summer of 1979.

Minor occurrences of sulphide mineralization in the Wollaston Group and minor uranium bloom on some granitic outcrop surfaces was encountered during the present work.

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